BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF HAWAII

In the Matter of the Application of	)	
	)	
PUBLIC UTILITIES COMMISSION	)	DOCKET NO. 2008-0273
	)	
Instituting a Proceeding to Investigate the Implementation of Feed-in Tariffs.	)	
	)	
	)	
______________________________	)	

FILED

2009 MAY -8 P 3: 27

PUBLIC UTILITIES COMMISSION

TAWHIRI POWER LLC'S SUBMISSIONS OF INFOMRATION;

EXHIBITS "A" THROUGH "D";

AND

CERTIFICATE OF SERVICE

HARLAN Y. KIMURA
ATTORNEY AT LAW, A LAW CORPORATION
Central Pacific Plaza
220 South King Street, Suite 1660
Honolulu, Hawaii 96813
Telephone No. (808) 521-4134

Attorney for Tawhiri Power LLC

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF HAWAII

In the Matter of the Application of	)	
	)	
PUBLIC UTILITIES COMMISSION	)	DOCKET NO. 2008-0273
	)	
Instituting a Proceeding to Investigate the Implementation of Feed-in Tariffs.	)	
	)	
	)	

TAWHIRI POWER LLC'S
SUBMISSIONS OF INFORMATION

TO THE HONORABLE PUBLIC UTILITIES COMMISSION OF THE STATE OF HAWAII:

Pursuant to the Hawaii Public Utilities Commission's (the "Commission") Order Granting The County Of Hawaii's Motion For Approval To Amend its Status As An Intervenor To A Participant, Filed On April 8, 2009; Granting The City And County Of Honolulu's Motion For Approval To Amend its Status As An Intervenor To A Participant, Filed On April 8, 2009; Amending Hawaii Holdings, LLC, Doing Business As First Wind And Sempra Generation's Status As Intervenors To Participants; And Amending The Schedule In This Proceedings, filed herein on April 27, 2009 ("Procedural Order II"), TAWHIRI POWER LLC ("TPL") hereby submits to the Commission its Submissions Of Information. Further, attached hereto as Exhibits "A" through "D" and made a part hereof, are the supplements to the aforesaid Submissions Of Information prepared by TPL's two (2) Consultants and Expert Witnesses, Dr. Mohamed El-Gasseir and Mr. Harrison Clark, with respect to the same. The Curricula Vitae of Dr. El-Gasseir and Mr. Clark were provided to the Commission on April 8, 2009, and a courtesy copy of the same is attached hereto as Exhibit "A" and made a part hereof.

I. ADDITIONAL COST TO SMALL WIND FACILITIES TO REMOTELY CURTAIL THEIR GENERATION.

In the afternoon session of Panel I, Mr. Harrison Clark was asked by Moderator Scott Hempling ("the Moderator") if he knew what the additional cost to small wind projects would be if communications and hardware/software controls were installed to enable them to be curtailed from a remote location. Tr. Vol. I, p. 309-10. This inquiry was a follow-up to TPL's Response to Information Request No. 57 from The National Regulatory Research Institute ("NRRI") filed herein on March 16, 2009. Since Mr. Clark was testifying via Conference Call, his answer to this inquiry could not be readily discernable. Id. at pp. 310-13.

TPL has requested Mr. Clark to conduct further research on the aforesaid inquiry to provide a more useful answer to the Commission. In that regard, the following is offered by Mr. Clark:

> Normally, utility system control and data acquisition (SCADA) systems that communicate over utility-owned transmission lines or fiber or microwave systems are used for such tasks. However, because SCADA systems typically service only transmission and distribution substations they are directly useful only for the larger generating plants and not for locations on distribution feeders. For larger plants controlled by SCADA systems, equipment costing several thousand dollars must be added at the interface between the SCADA system and the solar or wind plant.
>
> Direct load control has been widely implemented on distribution systems across the country for approximately $100 per customer. Radio signals have been generally accepted for some time, and is the technology presently being utilized by Pacific Gas & Electric's (PG&E) Smart AC demand control program which is anticipated to serve 400,000 of PG&E"s 1.5 million customers. These radio systems allow virtually instantaneous response. In such applications, a single

radio transmitter is normally used to control hundreds or thousands of air conditioners. However, digital encoding allows radio signals to control specific devices such as individual solar or wind plants where individual curtailment is desirable. For instance, a utility SCADA system would deliver curtailment signals to the applicable distribution substation(s) and immediately thereafter, those signals would be relayed by radio to solar and wind plants served by the targeted distribution substation(s).

A limited system serving only a few dozen, or a few hundred solar or wind generators, would be significantly more costly because of diseconomies of scale. Nonetheless, that limited system would probably cost less than $1,000 per generating unit. In other situations where solar and wind plant controls could complement a modern metering infrastructure (AMI) or a demand response system capable of reaching most customers, the cost would be only a few hundred dollars per generating plant.

Due to the capabilities of the internet and fiber optic cable, coaxial cable, and digital subscriber line (DSL) technologies, anyone could program their home digital video recorder from their cell phone while enjoying a meal at a restaurant. Moreover, voice over internet protocol (VOIP) allows world-wide voice communication without any discernable delay may be used for remote-control applications that once required phone lines employing audio tones. Such newer and improved technologies are designed to be economically tasked to instantaneously adjust or curtail the output of small solar and wind plants. Even an independent internet based system designed specifically for solar and wind plant control in a HECO system would be relatively economical, costing less than $500 per plant provided a few hundred plants were involved. The security of such systems may be of concern. However, this type of communication is as secure as email and VOIP services and may be further protected with encryption to increase security.

In summary, the costs to install remote curtailment mechanisms in FiT generators will depend on the number of plants in service, the extent to which those plants are dispersed across the system, whether individual plant controls would be required, and the rate of growth in plant installations. Depending upon those factors, the costs would probably be a few hundred dollars per generating unit. However, in no event should the cost be more than $1,000 per plant.

II. EXPLANTION FOR VARIABILITY IN INTERCONNECTION COSTS AS A STEP FUNCTION OF GENERATOR RATING.

In the afternoon session of Panel III, Dr. El-Gasseir advised the Commission that the interconnection costs of a FiT Generator "is sort of the step function of the size of the machines." Tr. Vol. II, p. 255. In other words, and as previously set forth in TPL's Response to Information Request No. 52 from NRRI filed herein on March 16, 2009, "if you increase just one kilowatt above a certain limit, it becomes pretty heavy [(i.e. costly)] until you reach the 99^{th} percentile before you get into the other level of initial cost." Id. at pp-255-56. The Moderator requested Dr. El-Gasseir to reduce to writing the "specific information request that [TPL] had concerning the relationship between interconnection costs and project size". Tr. Vol. II, p. 257.

Pursuant to the Moderator's request, TPL explains that there are two components to interconnection costs:

- The costs associated with the essential equipment for the projects such as metering cabinets, protection equipment, and switching and communication devices that link to the utility substation or control center, etc.
- The costs or credits reflecting the system reinforcement required with different levels of new generating capacity depending upon the location(s) of their interconnection to the utility's system.

The first category involves interconnection requirements utilities typically prescribe for independent power projects (IPPs) as well as in-plant distribution equipment. Such requirements uniformly apply to all IPPs regardless of location; varying primarily with voltage levels and to a lesser extent other factors such as the number of individual solar panel systems or wind turbines.

The second category of interconnection costs focuses on the utilities transmission and distribution lines, and associated substation, and switching, protection and communications equipment. Exhibit "B" examines those possible components and the variables that affect their costs. TPL submits that the HECO Companies should provide sufficient information regarding this second category to facilitate the unbundling of interconnection costs from the other project development capital requirements. This step is essential to an equitable and efficient design of PBFiTs.

This second category of interconnection costs (or credits) is a totally unknown quantity for IPPs and has been a major impediment for renewable energy development in many states, including Hawaii. If timely and sufficient information in this area is made available by the host utility, an investor will be able to readily determine the interconnection equipment described in Exhibit B required for its renewable energy project. On the other hand, there is virtually no chance of identifying the costs of system reinforcements related to a proposed project without a concerted effort by the host utility to have available that information formatted on a location-specific basis.

Having reasonably informative estimates of the total cost of interconnection for any specific candidate site and generating plant size is as vital for evaluating the economic efficacy of a contemplated project as it is vital for designing efficient tariff rates. This is due to the "lumpiness" of such costs and their variability depending upon project size and location as illustrated in Table 1. The hypothetical example in Table 1 involves a situation where a utility foresees four levels (steps) of system reinforcement costs (SRCs), each reflecting a tier (range) of total new generating capacity additions at a given location.[1]

TABLE 1

HYPOTHETICAL ILLUSTRATION OF THE STEP NATURE OF INTERCONNECTION COSTS

Tier	Generator Size (kW)	System Reinforcement Costs	
		Total Dollars	Dollar per kW
1	0.00	0	0
	9.99	0	0
2	10.00	100,000	10,000
	99.99	100,000	1,000
3	100.00	200,000	2,000
	499.99	200,000	400
4	500.00	400,000	800
	5,000.00	400,000	80

Clearly, the consequences of lacking such information in advance include:

[1] In real applications, there might be cases with only one or two tiers.

- Developers wasting valuable time and resources designing a project, preparing the application for interconnection, and then waiting for the utility to determine the required system upgrades and costs only to learn that the interconnection costs would render the proposed project uneconomical. For instance, as indicated by Table 1, investing in a 500-kW generator instead of selecting a 499-kW facility could double the SRC component of the interconnection costs for the unsuspecting developer.[2]
- Impossibility of a FiT rate schedule being effective when interconnections ranging from zero to $10,000 per kW, or more, remain hidden behind yet-to-be performed System Reinforcement Studies (SRSs).

Sound PBFiT design and efficient developer participation require the following approach to resolving this interconnection conundrum:

1. Unbundling of interconnection costs into: (i) plant-side-of-the fence equipment requirements, and (ii) utility SRCs;
2. Determination of the generic (universal) interconnection requirements by voltage class and other factors; and
3. Determination and publication of the SRCs on an annual basis in a manner similar to the Phonebook concept adopted by the California Public Utilities Commission (CPUC) for its Standard Offer process as documented in Section III of this Submissions of Information.

Once the information from the above Steps 2 and 3 are made available, the

[2] This situation could result when that extra kW breaks a threshold requiring re-conductoring of the transmission line.

Commission could proceed with structuring PBFiT rates that will better encourage renewable energy growth by minimizing the risk of over-subsidization, while reducing developer costs and risks. It should be noted that identifying and quantifying system reinforcement costs in this transparent manner will also assist the Commission in resolving the issue of who will pay, and how to pay, such costs, especially when multiple developers are involved. The time to resolve this issue is the present, and the aforesaid provides a cogent reason for limiting FiT implementation to trial applications of one or two years.

III. INFORMATION CONCERNING HECO COMPANIES' INTERCONNECTION REQUIREMENTS MODELED AFTER THE CALIFORNIA PHONEBOOK EXAMPLE.

In the afternoon session of Panel IV, Dr. El-Gassier suggested "the phone book [method] in California" as a means to facilitate the interconnection of Project-Based Feed-In-Tariff Generators ("PBFiT Generators") to the utility's grid ("Phonebook"). Tr. Vol. III, p. 181-84. Essentially, the phonebook concept involves identifying all locations for interconnection by a developer <u>and</u> specifying the following information for each identified location:

- The required interconnection voltage level;
- The maximum generating capacity permissible at that interconnection;
- The cost or credit representing the monetary value of the system reinforcement impacts associated with different tiers of total interconnected generating capacity; and
- Other related information.

Such phonebook information would be made available equally, and in a fully transparent manner, to all potential developers on a regular basis with annual updates to reflect the latest system changes. Potential PBFiT generators, as well as participants in other renewable energy development programs, would then use that information to evaluate and compare the economics of candidate locations for their projects. Attached hereto as Exhibit "C" is a proposed Phonebook format that may be utilized as an initial template for the HECO Companies. This format is modeled after the Phonebook concept used in California prior to the restructuring of its electric power industry. In addition to the information requirements outlined above, Exhibit C includes loss factor data to enable further locational cost/benefit differentiation between alternative sites.

By service of an electronic copy of this Submission of Information, the HECO Companies are requested to respond directly to TPL regarding whether the information presented in the proposed format would be acceptable for public dissemination and what changes if any should be made.[3]

The Moderator requested the citation for the California Public Utilities Commission ("CPUC") records concerning the Phonebook concept to facilitate interconnection with Independent Power Producers. That pertinent citation is CPUC Decisions 92-11-060, 92-12-021, 92-09-078 and 93-03-20. Exhibit D provides a copy of a page from the Phonebook developed by Pacific Gas and Electric Company in response to CPUC directives.

[3] The Moderator suggested TPL discuss with the HECO Companies whether they would be able to provide the requested information for inclusion in the Phonebook. Tr. Vol. III, p. 183. According to the Moderator, this "would be very useful to the Commission." Id.

Confidential Information
Deleted Pursuant To
Protective Order Filed on
January 6, 2009

IV. TPL's GENERATION IN 2007 AND 2008 IN RELATION TO ITS CURTAILMENT BY HELCO FOR THOSE YEARS.

Also in the afternoon session of Panel IV, Mr. Adam Pollock from NRRI asked Dr. El-Gasseir for the "percent of the time that the Tawhiri wind farm would otherwise be running [if it were not] currently curtailed?" Tr. Vol. III, p. 218. Dr. El-Gasseir responded that HELCO curtailed TPL by 12,000,000 kilowatt hours in 2007 and 18,000,000 kilowatt hours in 2008. Id. at p. 219. Since Mr. Pollock further requested information concerning the total generation for those years, Dr. El-Gasseir agreed to provide the same to the Commission under protective order. Id. In that regard, the total generation of the Pakini Nui Wind Farm for 2007 was [redacted] kilowatt hours, and [redacted] for 2008.

V. REQUEST FOR GE STUDY CONCERNING SYSTEM RELIABILITY.

In the morning session of Panel VIII, Dr. El-Gasseir responded to Commissioner Leslie H. Kondo's observation concerning the lack of detailed expert testimony on reliability at these Panel Hearings by pointing out the failure of the HECO Companies to provide the type of information needed to enable such contribution. He cited in particular the lack of access to "a study that was done by General Electric, very recent study by people [he knew] personally." Tr. Vol. V, pp. 103-04. According to Dr. El-Gasseir's recollection, TPL had previously requested access to the aforesaid study that was recently performed by General Electric to evaluate system reliability impacts of high renewable energy penetration (the "GE Study"). See Id. at 104. Specifically, TPL's Information Request No. 11 directed to the HECO Companies and Consumer Advocate ("TPL-IR-11") states:

> **Please provide documentation** of the following examples you cited in your response to Haiku Design & Analysis' Information Request No. 5 To HECO ("HDA/HECO-IR-5") as evidence of the measures already taken by HELCO to improve it "ability to effectively integrate existing and new variable generators" with respect to:
>
> a. "modifications to the HELCO AGC system to reduce the responsiveness of the system to short term fluctuations in power output of as-available generation to avoid overcompensating for these types of fluctuations;"
>
> b. "modifications and tuning of the control systems for HELCO generating units to increase their responsiveness to respond to fluctuations in as-available generation output;"
>
> c. "increasing the regulating reserve carried on the HELCO grid to provide greater upward ramping capability of online generators to respond to sustained drop offs of as-available generation;"
>
> d. "HELCO transmission projects which have increased east-to-west transmission capacity that also allow for greater operating flexibility of dispatchable generation to reduce excess energy and curtailment of as-available generation;"
>
> e. "a HELCO system stability study to define the minimum amount of steam generation (i.e., generation with higher rotational inertia) that is required to run at all times to ensure the stability of the system during typical emergency events such as transmission system faults, thus allowing better understanding and quantification of the amount of wind and PV energy (i.e., generation with very little to no rotational inertia) that the system can reliably accommodate;"
>
> f. the system studies being undertaken "to better understand what additional modifications are needed in operating practices and existing generation and T&D equipment, as well as the types and attributes needed from new demand response programs and generating units in order to increase the grid's ability to integrate as available generation"; and
>
> g. The study being initiated "to research and develop wind forecasting capabilities that predicts periods of higher risk for large and rapid wind ramping events using available meteorological data available for the Hawaii Island system."

[Emphasis added].

In response, the HECO Companies disclosed the existence of two (2) EPRI reports. Those reports were: (1) *EPRI Evaluation of the Effectiveness of AGC Alterations for Improved Control with Significant Wind Generation,* EPRI, Palo Alto, CA: 2007. 1018715; and (2) *Evaluation of the Impacts of Wind Generation on HELCO AGC and System Performance – Phase 2.* EPRI, Palo Alto, CA: 2009. 1018716 ("EPRI Reports"). Although it is not clear whether the EPRI Reports are related to the GE Study referenced by Dr. El-Gasseir, these documents should have been provided to TPL pursuant to TPL-IR-11.[4] In any event, since the citations to the EPRI Reports were included in the HECO Companies' response to TPL-IR-11, TPL contacted EPRI directly for the same. In doing so, TPL was advised the EPRI Reports were "unavailable because they were out of circulation – inactive." Therefore, the HECO Companies are requested to provide copies of the EPRI Reports, the GE Study, and the system impact planning studies performed by Electric Power Systems Inc.[5], to Counsel for TPL on or before **May 12, 2009**, in order that their contents thereof may be incorporated into TPL's Opening Brief, if appropriate.

VI. COMMENTS ON INFORMATION REQUESTS OF THE NATIONAL REGULATORY RESEARCH INSTITUTE DATED MAY 7, 2009

Requests # 1, and 5 through 8: TPL has no comments at

[4] The HECO Companies did not object to the production of the EPRI Reports on grounds of confidentiality, or that they were contractually prohibited from disclosing the same. Therefore, the EPRI Reports should have been provided to TPL on or before March 13, 2009. They were not.
[5] These studies were also referenced by the HECO Companies in their response to TPL-IR-11 (i.e. part e) at page 2 of 4).

this time on the issues raised in these requests.

Request # 2: Should the FiT be extended to incremental expansions of existing projects? HECO indicated technical or administrative difficulty in determining how much power would come from incremental additions. We asked HECO and developers to describe to what extent would this be possible?

TPL Response: As a matter of principle, TPL believes all developers and projects should be afforded equal opportunity to choose between different renewable development programs. There is no technical impediment to determining the extent to which power may be received from incremental additions. A separate metering and settlement arrangement could be set up. It may be possible to agree on using a simple capacity-ratios based mechanism to allocate production contributions and payments. The consequent increase in administrative costs would not be materially different from those associated with a new stand-alone facility.

Request # 3: What reliability standards could HECO craft to add transparency, if not predictability, to HECO's reliability determinations for FiT applicants?

TPL Response: TPL believes the real need is for streamlining system planning and system impact studies in a fully transparent manner and to provide interconnection capability and costing information on a regular basis to all developers. This goal may be achieved without compromising reliability performance. TPL's proposed Phonebook approach would accomplish this as described earlier in this Submissions of Information.

Request # 4: We asked HECO if it would be possible to provide better circuit-level data to developers so that they can predict where IRS studies would be triggered. HECO indicated that they only have SCADA data for 20% of circuits. This issue may be outside the scope of the FiT, but is something that the utility and developers should address to improve the FiT's implementation.

TPL Response: The proper solution is the approach TPL has described in Sections II and III of this Submissions of Information.

VII. COMMENT ON THE NATIONAL REGULATORY RESEARCH INSTITUTE QUESTIONS TO BE ADDRESSED IN BREIFINGS

TPL commends the NRRI for identifying and articulating the essential issues for the briefing phase of this proceeding. We intend to address the most pertinent ones in TPL's Opening Brief.

Respectfully submitted.

DATED: Honolulu, Hawaii, May 8, 2009.

HARLAN Y. KIMURA

Attorney for Movant
Tawhiri Power LLC

HARLAN Y. KIMURA
Attorney At Law, A Law Corporation
Central Pacific Plaza
220 South King Street Suite 1660
Honolulu, Hawaii 96813

Tel (808) 521-4134
Fax (808) 521-0361

E-mail hyk@aloha.net

April 8 2009

The Honorable Chairman and Members of the
Hawaii Public Utilities Commission
465 South King Street
Kekuanaoa Building, Room 103
Honolulu, HI 96813
Attn: Stacy Kawasaki Djou, Esq.

Re: Docket No. 2008-0273 – In the Matter of Public Utilities Commission Instituting a Proceeding to Investigate the Implementation of Feed-In Tariff: Curricula Vitae of Tawhiri Power LLC's Expert Witnesses

Dear Commissioners and Commission Staff:

Pursuant to Chairman Carlito P. Caliboso's letter dated April 7, 2009, attached please find the Curricula Vitae of the Expert Witnesses for Tawhiri Power LLC.

If you have any questions regarding the above, or enclosed, please feel free to contact the undersigned. Thank you for your assistance with this matter.

Very truly yours,

Harlan Y. Kimura

Attachments

cc Service List (w/ attachment)
Tawhiri Power LLC (w/ attachment)

EXHIBIT "A"

Mohamed El-Gasseir, Ph.D.

April 2009

Principal Areas of Expertise

- Developing methodologies for seamless integration of pricing and investment programs for distributed resources, self-generation, feed-in-tariffs and Qualifying Facilities
- Distributed resources and self generation planning, assessment and policy analysis
- Configuration and assessment of high-voltage dc and ac transmission systems integration applications
- Simulation and analysis of failure modes, repair cycles and outage damage functions
- Purchase-power agreements (PPAs) contracting and due diligence applications
- Renewable power market assessments and project development
- Stochastic price forecasting for risk management and bid evaluations
- Developing transmission access for renewable resources
- Identification and assessment of on-site generation investment opportunities
- Integrated (generation and T&D) cost effectiveness studies of generation investments in central power plants, distributed resources and DSM alternatives

Employment History

2006- Present Rumla Engineering Consultations & Technical Services, Inc., Principal

2003- Present DC Interconnect, Inc., Principal

1992- Present Rumla, Inc., Principal

1991 - 1992 Barrington-Wellesley Group, Senior Associate

1988 - 1989 Mechanical Engineering Department, University of California, Berkeley, Lecturer

1981 - 1991 Independent energy consultant

1978 - 1981 Lawrence Berkeley Laboratory Energy Program, Research Assistant Associate

1976 - 1977 U.S. Council on Environmental Quality and National Academy of Sciences Committee on Nuclear and Alternative Energy Systems, Consultant

Academic Background and Professional Associations

- Ph.D. in Energy and Resources, University of California at Berkeley (1986)
- M.S., Chemical Engineering, University of Rochester, New York (1974)
- B.Sc., Chemical Engineering, University of California at Berkeley (1972)
- AAAS, ACEEE and IEEE member

Sample Conducted Courses and Industry Seminars

- "Staff Workshop to Review Analysis of the Self-Generation Incentive Program", California Energy Commission, Sacramento, California, September 3, 2008
- "Emerging Grid Reliability Improvement Technologies and Their Control Requirements", Power Grid Europe Conference, Milan, Italy, June, 2008
- "Emerging HVDC Technologies, Controls and Applications", Power Grid Europe Conference, Madrid, Spain, June 26-28, 2007
- "Experience with MAPS Modeling for Post-MD02 California Markets", GE MAPS Users Conference, Washington D.C., October 16-17, 2003
- "Analyzing the Potential for Price Spikes", Workshop for the Electric Power Industry, Washington, D.C., March 26, 1999
- "Distributed Generations: Assessing High-Value Utility Applications", First EPRI Workshop on Distributed Generation, New Orleans, Louisiana, September 1992
- Engineering 160 (course): Basic Thermodynamics and Energy Conversion Processes, University of California, Berkeley

Selected Publications, Reports and Conference Presentations

"Identification and Mitigation of Weak Buses & Transmission Corridors and Evaluation of Performance Improvements versus Mitigation Measures Costs of Large Interconnected Transmission Grids", EPRI, Palo Alto, CA and DCI, Vancouver, B.C., Canada, 2009

Cost-Benefit Analysis of the Self-Generation Incentive Program, October 2008, CEC-300-2008-010-F, [illegible]

"The Application of Segmentation and Grid Shock Absorber Concept for Reliable Power Grids", Middle East Power Conference, MEPCON, March 2008

"Softening the Blow of Disturbances: Segmentation with Grid Shock Absorbers for Reliability of Large Transmission Interconnections", M.M.El-Gasseir, et al., *IEEE Power & Energy Magazine*, Jan Feb 2008, pp 30-41

"Emerging Grid Reliability: Improvement Technologies: A Perspective on Segmentation, the Grid Shock Absorber Concept, and Competing Technologies." EPRI, Palo Alto, CA and DCI, Vancouver, B.C., Canada: 2007, 1013996

"Intermittency Analysis Project", Final Report, Prepared by the Intermittency Analysis Team (Rumla, Inc. et al) for the California Energy Commission PIER Program, July 2007

"Feasibility of using HVDC Technology for Reinforcing the Interior to Lower Mainland Transmission Grid", DC Interconnect Report Prepared for BCTC, June 2007

"Assessing System Benefits of Renewable Trunkline Transmission Projects", Consultant Report Prepared for the California Energy Commission, December 2006

"Technical Assessment of Grid Shock Absorber Concept", EP-P20414 C9939, DC Interconnect Report, July 2006

"Potential Impacts on Long-Term Zonal-Contracts from the Amended Market Design as Proposed in the July 22, 2003 filing of the California Independent System Operators before the Federal Energy Regulatory Commission", Confidential Draft Final Report, prepared for the California Energy Resources Scheduling Division, California Department of Water Resources, July 2, 2004

"Transmission Planning for an Industry in Transition – The Schizoid Environment of Transmission Investments Planning", Transmission Expansion and Systems in Transition Conference, Miami, FL, February 8, 2002

"Transmission Planning for an Industry in Transition – Towards Comprehensive Regulatory and Market Reforms for a More Efficient Power Industry", Transmission Expansion and Systems in Transition Conference, Miami, FL, February 8, 2002

"Review and Analysis of Administrative Charge Practices of Independent System Operators", Prepared for Independent Electricity Market Operator of Ontario, Canada, Final Report, May 15, 2001

"The Role of Transmission Pricing & Management in Precipitating the Current Crisis in California & Prospects for Reform",

Transmission Grid Expansion and System Reliability Conference II: Focus on Pricing, May 24, 2001, Denver, Colorado

"California's State Takeover of Transmission Assets", Transmission Grid Expansion and System Reliability Conference I: Focus on Regulation, May 21, 2001, Denver, Colorado" The Problems of Modeling Transient Energy Markets", Electricity Market Pricing Conference, Vail, Colorado, August9-10, 1999

"Transmission Development in the U.S. and Implications for Canadian Providers", Electricity '99 Conference, Canadian Electric Association, Vancouver, B.C., March 29, 1999

"Working with Transmission Loading Relief (TLR) to Prevent Future Supply Problems and Relieve Congestion on the Grid", Infocast Workshop Conference on Congestion Management, Washington, D.C., March 25, 1999

"Implications of Super-ISOs for the Business Strategies of Power Market Players", Infocast Conference on Congestion Pricing & Tariffs, Washington DC, September, 1998

"System Operation Models for an Open Market: A Framework and Alternative Study", presented at the Annual Brazil Utilities Conference, Brazil, May 1998

"Atlantic City Electric Company Audit of Stranded Costs: Final Report", with Barrington-Wellesley Group, prepared for New Jersey Board of Public Utilities Docket No. EO97070456, December 1997

"Access Fee Consolidation Proposal for the Western Interconnection", presented at Western Regional Transmission Association, Salt Lack City, July 1997

"Distributed Technologies Characterization And Assessment Phase Two Report: Assessing Local Area Integrated Planning of Distributed Generation, Storage and Demand Side Management Investments for Deferring Planned Distribution System Upgrades", prepared for Detroit Edison Company, December 1995

"Dispatchable Distributed Generation Characterization And Assessment For Long Island Lighting Company", prepared for the Long Island Lighting Company, November 1995

"DISTRIBUTED GENERATION: Implications for Restructuring the Electric Power Industry", Public Utilities Fortnightly, June 15, 1995

"Distributed Generation Characterization and Assessment for San Diego Gas & Electric", prepared for the Electric Power Research Institute (EPRI), October 1994

"Distributed Resources Assessment in the Service Territory of Anza Electric Cooperative", prepared for the Electric Power Research Institute (EPRI), October 1994

"Distributed Generation Assessment for Azienda energetica municipale of the City of Milan – Phase I, Siting and Technology Screening for High Value Applications", prepared for the Electric Power Research Institute (EPRI), October 1994

"Distributed Generation Assessment Guidelines – A Market-Based Framework for Evaluating High-Value Applications", prepared for the Electric Power Research Institute, December 1993

"Distributed Generation Assessment, Evaluation, and Practice Program – Dis-Gen Practice", prepared for the Electric Power Research Institute (EPRI), November, 1993

"Assessment of the Benefits of Distributed Fuel Cell Generators in the Service Areas of Central & South West Services, Inc.", prepared for EPRI, October 1993

"Carbonate Fuel Cells and Diesels as Distributed Generation Resources – Economic Assessment of Application Case Studies at Oglethorpe Power Corporation", prepared for the Electric Power Research Institute (EPRI), October 1993

"Molten Carbonate Fuel Cells as Distributed-Generation Resources: Case studies for the Los Angeles Department of Water and Power", prepared for EPRI, May 1992

"Recent Developments Affecting Canadian Energy Exports to California and Other U.S. Markets", presented at the North American Electric Power Generation Demand for Canadian Natural Gas in the 1990s Conference, November 1991

"Need Assessment of the Tondu Cogeneration Facility", Independent Power Corporation, Testimony before the Michigan Public Service Commission, December 23, 1986

"Long-Term Projections of Avoided Energy Costs" for Pacific Gas and Electric Company, Independent Power Corporation, Prepared for Combustion Engineering Inc., Dec. 12, 1986

"Analysis of the Cost Competitiveness of Coal-Fired Electric Generation vs. Purchase Power" for the Arizona Electric Power Cooperative, Independent Power Corp., Nov. 1986

"Brief of the Nevada Mining Association, Before the Public Service Commission of Nevada", Docket No. 86-701, October 23, 1986

"Supplemental Testimony of Independent Power Corp. on behalf of the Nevada Mining Assoc., before Public Service Commission of Nevada", Docket No. 86-701, Sept. 22, 1986

"Testimony of Independent Power Corporation on behalf of The Nevada Mining Association, Before the Public Service Commission of Nevada", Docket No. 86-701, September 10, 1986

"Pacific Gas and Electric System Operation Characteristics and Effects on Geothermal Steam Prices and Revenues", Prepared for Graham & James, July 22, 1986

"Baseline Projections of Avoided Energy Costs and Incremental Energy Rates for California's Investor Owned Utilities", prepared for Pacific Lighting Energy Systems, June 17, 1986

"General Assessment of Trends in Cogeneration Fuel Prices, Avoided Costs and Retail Electric Rates of Pacific Gas & Electric Co. 1986-2000", for Chevron USA, April 11, 1986

"Projection of the Likely Range of Incremental Energy Rates and Avoided Energy Costs of Pacific Gas & Electric Company", prepared for Signal Capital Corporation, October 22, 1985

"Projected Prices for Pacific Gas & Electric Co. Geothermal Steam at the Geysers 1986-2000", Independent Power Corp., for Kidder, Peabody & Company, October 18, 1985

"Initial Assessment of the Avoided Energy Costs of Pacific Gas and Electric Company and Southern California Edison", for Power Systems Engineering, Inc., September 10, 1985

"Review of California Utility Fuel Price Forecasts", for Signal Capital Corp., Sept. 5, 1985

"Projected Prices for Pacific Gas & Electric Company Geothermal Steam at the Geysers 1986-1995", Independent Power Corp., for Chevron Resources Company, August 29, 1985

"Desk-Top Computer Modeling for Electric Utilities: A Survey of Hardware Software Compatibility", SERA Report No. 85-190, January 1985

"Tension Leg Inservice Non-Destructive Examination System Phase II Reliability Study: Reliability and System Effectiveness Assessment", Final Report to Sigma Research Inc. Conoco U.K. Ltd., SERA No. 84-181, November 1984

"Review of Centaur G Prime Reliability Analyses for the Radioisotope Thermo-electric Generator (RTG) Safety Study for the Galileo and International Solar Polar Space Mission: Addendum to Review of Shuttle Centaur Failure Probability Estimates for Space Nuclear Mission Applications", Report for Teledyne Energy Systems, Inc. Air Force Weapons Laboratory, SERA No. 84-146, September 1984

"Review and Analysis of the Nevada Power Company 1984-2004 Resource Planning Submittal" Report to the Public Service Commission of Nevada and the Nevada Office of Consumers' Advocate, SERA No. 84-155, August 1984

"Review and Evaluation of the Sierra Pacific Power Company 1984-2004 Resource Planning Submittal", Report to the Public Service Commission of Nevada and the Nevada Office of Consumers' Advocate, SERA No. 84-152, August 1984

"Analysis in Support of Assessment of BPA's Short Term Rates and Load Balances", SERA, Inc., Report to Southern California Edison, SERA No. 84-126, March 1984

"Electric Utility Demand Forecasting and Resource Planning in Nevada: A Review of State-of-the-Art Methods and Recommendations for Regulatory Oversight", Dec. 1983

"The Legislative and Contractual Framework for Power Transactions in the Pacific Northwest", Report to the Southern California Edison Company, September 1983

"An Analysis of the WPPSS 3 Delay Decision by the Bonneville Power Administration", Report to the Southern California Edison Company, SERA No. 83-85, August 1983

"Feasibility Study of a Wood-Fired Electric Power Plant", Report to Shearson American Express, August 1983

"On the Bonneville Power Administration 1983 Proposed Wholesale Power Rates", Report to Southern California Edison Company, July 1983

"Pacific Northwest Electric Power Planning: Limitations & Opportunities, Sierra Energy and Risk Assessment, Inc.", Report to Southern California Edison Co., May 1983

"Energy and the Fate of Ecosystems", the report of the Ecosystem Impacts Resource Group of the Risk Impact Panel of the Committee on Nuclear and Alternative Energy Systems, National Research Council (National Academy Press, Washington, D.C., 1980)

Book Review: Water in Synthetic Fuel Production, The Technology and Alternatives, R. E. Probstein and H. Gold, Water Resources Bulletin, V. 15, No. 5, pp. 1477-1478, October 1979

College of Engineering Interdisciplinary Studies, California Power Plant Siting with Emphasis on Alternatives for Cooling, 1977-78 (U. of Calif., Berkeley College of Eng. Report 78-2, 1978)

Harte, J. and M. El-Gasseir, Energy and Water, Science 199: 623-624, February 10, 1978

Harte, J., et al., Environmental Consequences of Energy Technology: Bringing the Losses of Environmental Services into the Balance Sheets, Part II: Services, Disruptions, Consequences, (Energy and Resources Group, Univ. of California, Berkeley, ERG-WP-77-2, October 1977)

Testimonies:

Performance audit on post-restructuring purchase power practices of Pacific Gas and Electric Power Company for the California Public Utilities Commission (CPUC) (testimony before the CPUC), 2001

Evaluation of IOU-proposed transmission loss factor estimation techniques based on the ISO's Generator Meter Multipliers methodology (testimony before the CPUC), 2000

Development of auction strategies and rules for procuring wholesale Standard Offer service to meet customer-load obligations of New England investor-owned utilities (testimony support before the Department of Energy and telecommunications of Massachusetts), 1999

"Atlantic City Electric Company Audit of Stranded Costs: Final Report", with Barrington-Wellesley Group (testimony support before the New Jersey Board of Public Utilities Control), 1997

Designing rules and regulations governing utility purchases of independently generated power and developed contract language for standard offers to qualifying facility projects (CPUC testimony), 1993

Evaluation of U.S.-Canada Free Trade Agreement impacts on power trade (testimony before California legislature), 1993

Development of methodologies for forecasting available transfer capability on the Pacific AC Intertie transmission system and associated impacts of inter-regional surplus power trade (testimony before the California Energy Commission), 1989

Assessing prospects for financing and construction of the California-Oregon Transmission Project and the Third AC Intertie (California Energy Commission testimony), 1988

Contract performance evaluation of major utilities involved in a long-term multi-lateral agreement for the sale, exchange and banking of electricity (litigation support), 1987

"Review and Analysis of the Nevada Power Company 1984-2004 Resource Planning Submittal" (testimony before the Public Service Commission of Nevada), 1984

HARRISON K. CLARK, Consultant

Mr. Clark received the BSEE degree from California State Polytechnic University (Cal Poly), San Luis Obispo, CA in 1966. He joined General Electric that year and over the next four years completed several graduate level courses including the GE "A Course" while performing conceptual design, power flow, stability, and protection studies for GE's largest paper, chemical, and petroleum clients.

In 1970 Mr. Clark joined Power Technologies, Inc (PTI). His work at PTI included equipment failure analysis, transmission planning, blackout investigations and criteria development. He helped guide development of the PTI PSS/E stability program and has analyzed stability and voltage collapse problems and developed protection philosophy and solutions to overvoltage, loss-of-synchronism, and self-excitation problems.

His transmission planning work has involved all voltage levels and all of the available techniques for maximizing transfer capability including re-closing, series capacitors and reactors, shunt compensation, braking resistors, unit tripping, stabilizers, fast valve actuation, high performance excitation systems and remedial action schemes. He developed new extensions to digital governing on hydro plants in Alaska, including novel use of Pelton turbine deflectors for both stability and rapid black-out recovery.

Mr. Clark's early industrial experience allowed him to make significant contributions to electric power industry efforts to improve simulations of customer loads in first-swing, oscillatory and voltage stability analysis. Models he developed include induction motor dynamics, discharge lighting, magnetic saturation, and the effects of manual and automatic load controls such as thermostats. He developed QV analysis and other analytical methods and solutions to voltage collapse, as well as criteria to control risk of voltage collapse. He was an invited presenter at the first joint NSF/IEEE/EPRI Conference on Voltage Stability in 1988 and has made many subsequent presentations at WSCC, IEEE, and EPRI events.

He investigated nine major blackouts including the 1977 New York City blackout. This experience led to development of transmission planning and operating criteria for clients in Canada, the U.S., Norway, and Central America. He has presented expert testimony in legal proceedings in Canada and in both State and Federal proceedings in the U.S.

Mr. Clark has taught PTI Short Courses on System Dynamics, HVDC, and Static Var Systems and portions of the two-year Power Technology Course. He created the PTI Voltage Stability Course, presented to over 1000 students world-wide. He was a major contributor to EPRI's first operator training course.

At PTI Mr. Clark was promoted to Senior Engineer in 1974; Manager, Utility System Performance in 1984; and Manager, Western Office in 1987. He is a Senior Member of IEEE and has presented or published 43 papers and articles. Mr. Clark retired from PTI in 1996 and is now an independent consultant. In 1977 he was selected by BPA to serve on the Blue Ribbon Panel assembled to guide BPA in addressing major 1996 WSCC disturbances.

Recent activities include contributions to the Western Governor's Association August 2001 report "Conceptual Plans for Electricity Transmission in the West," several testimony assignments, assistance to a industry leading consulting firm on several voltage stability analyses, and assistance to clients in the Northeast following the August 14, 2003 blackout.

March 2008

Harrison K. Clark 8261 Berg Street Granite Bay CA 95746 www.hkclark.com 916 791-2284

Publications

1. "Load Shedding for Industrial Plants," Paper No. ICP-WTD-PM2 725, presented at Eighth Annual Meeting of IEEE Industry Applications Society, October 8-11, 1973
2. "Voltage Control in a large Industrialized Load Area Supplied by Remote Generation," Paper No. A 78 558-9, presented at IEEE PES Summer Meeting, July 17, 1978, (co-authors, T.F. Laskowski, A. Wey filho, and D.C.O. Alves)
3. "Transient Stability Sensitivity to Detailed Load Models: A Parametric Study," Paper No. A 78 559-78, presented at IEEE PES Summer Meeting, July 17, 1978, (co-author, T.F. Laskowski)
4. "Considerations in the Evaluation of Series and Shunt Compensation Alternatives," presented at the T&D Expo, Chicago, IL, May 14-16, 1985
5. "Microprocessor Based Load Shedding for Industrial Plants," presented at the IEEE Industry Applications Society I&CPS Conference, Cleveland, OH, May 5-8, 1986
6. "Enhancement of AC Systems by Application of DC Technology," EPRI Transmission Limitations Panel, IEEE-PES Winter Meeting, New Orleans, LA, February 2-6, 1987, and presented at the Symposium on Electrical Operational Planning, Rio de Janeiro, Brazil, August 17-21, 1987, (co-author, F.P. de Mello)
7. "Modeling to Define Limits to Shunt Compensation Use," Panel on Reactive Modeling Considerations, IEEE-PES Winter Meeting, New Orleans, LA, February 2-6, 1987
8. "Voltage Control and Reactive Supply Problems," IEEE Tutorial Course, REACTIVE POWER: BASICS, PROBLEMS AND SOLUTIONS, Publication 87 EH0262-6-PWR, presented at the IEEE-PES Summer Meeting, San Francisco, CA, July 12-17, 1987, and the Winter Meeting, New York, NY, 1988
9. "Dynamic Aspects of Excitation Systems and Power System Stabilizers," presented at the Symposium on Electrical Operational Planning, Rio de Janeiro, August 17-21, 1987, (co-authors, F.P. de Mello and L.N. Hannett)
10. "Reactive Compensation in Power Systems," presented at the Symposium on Electrical Operational Planning, Rio de Janeiro, August 17-21, 1987, (co-author, D.N. Ewart)
11. "Micro processor Based Load Shedding for the Pulp and Paper Industry," TAPPI Annual Meeting, New Orleans, LA, September 1987, and TAPPI JOURNAL, December, 1987
12. "Industrial and Cogeneration Protection Problems Requiring Simulations," IEEE Transactions on Industry Applications, Vol. 25, No. 4, July-Aug. 1989 (co-author, J.W. Feltes)
13. "The Case for Asynchronous Interconnection of China's Electrical Systems," presented at the Joint IEEE-CSEE Conference on High Voltage Transmission Systems in China, Beijing, The Peoples' Republic of China, October 17-22, 1987, (co-author, L.O. Barthold)
14. "Load Modeling for Power Flow and Stability Studies," presented at the 1988 WSCC Stability Seminar, Rosemead, CA, April 5-7, 1988
15. "Voltage Control and Reactive Supply Problems," presented at the 1988 WSCC Stability Seminar, Rosemead, CA, April 5-7, 1988
16. "Voltage Control Practices in North America," IEEE-NSF-EPRI Conference: Bulk Power System Voltage Phenomena--Voltage Stability and Security, Potosi, Missouri, September 19-24, 1988, Proceedings: EPRI Publication EL-6183.
17. "Experience with Load Models in the Simulation of Dynamic Phenomena," Panel on Load Modeling Impact on System Dynamic Performance, IEEE-PES Winter Meeting, New York, NY, January 30 - February 3, 1989.
18. "Long-Term Disturbance Monitoring for Improved System Analysis," IEEE Computer Applications in Power, Volume 2, No. 2, April 1989, (co-author, S.J. Balser)
19. "Analysis and Solutions for Bulk System Voltage Instability," IEEE Computer Applications in Power, Volume 2, No. 3, July 1989, (co-authot, G.C. Brownell)
20. "Voltage Stability of Power Systems: Concepts, Analytical Tools, and Industry Experience," Special Publication of the System Dynamic Performance Subcommittee of the Power System Engineering Committee of the IEEE PES, 1990, 90TH0358-2-PWR (multiple co-authors)
21. "New Challenge: Voltage Stability," IEEE Power Engineering Review, Volume 10, No 4, April 1990
22. "Load Modeling for System Dynamic Performance," special publication of the IEEE

PES Working Group on Load Modeling, September, 1991 (co-authors).

23. "Load Representation for Dynamic Performance Analysis," Paper by the IEEE Task Force on Load Representation for Dynamic Performance, Presented at the IEEE Winter Meeting, January 26-30, 1992, New York, NY (co-authors).

24. "Experience with Dynamic System Monitoring to Enhance System Stability Analysis," IEEE PES Summer Meeting, Long Is, 1991 (co-authors, R.K. Gupta, C. Loutan, D.R. Sutphin).

25. "The Voltage Collapse Phenomenon," 1991 Minnesota Power Systems Conference Proceedings, University of Minnesota, October, 1-3, 1991.

26. "Voltage Stability - Criteria, Planning Tools, Load Modeling," EPRI/NERC Forum on Operational and Planning Aspects of Voltage Stability, Breckenridge, Colorado, September 14 and 15, 1992.

27. "Voltage Stability: Load Modeling, Solutions, and Criteria," Presented at the WSCC Stability Seminar, June 3, 1992, Los Angeles.

28. "Application of Adjustable Speed Doubly Fed Machines in Pumped Storage and Conventional Hydro Electric Plants," Presented at the American Power Conference, 55th Annual Meeting, April 13, 14, 15, 1993, Chicago Illinois. (Co-authors Jan Stein, Roy Nakata, Peter Donalek)

29. "Technical and Economic Evaluation of Utility Battery Storage Applications," Presented at the Fourth International Conference, Batteries for Energy Storage, Berlin, Germany, September 27-October 1, 1993 (Co-author H.W. Zaininger)

30. "Suggested Techniques for Voltage Stability Analysis," Working Group on Voltage Stability, System Dynamic Performance Subcommittee, Power System Engineering Committee, Report 93TH0620-5PWR, (9 Co-authors).

31. "Voltage Stability and other Considerations in the Application of Field Current Limiters," Panel Session on Excitation System Limiter Application and Modeling, 1994 Summer Power Meeting.

32. "Minimizing the Cost of Voltage Stability," Presented at PTI Hospitality Suite at 1994 Summer Power Meeting.

33. "FACTS Applications," Special publication of the FACTS Application Working Group of the IEEE Power Engineering Society, Dec., 1995, PES Publication 96TP116-0, (multiple co-authors).

34. "Impact of Increasing Wind Generation on the Transmission System in the Republic of Ireland," Symposium - Neptun: Impact of DSM, IRP and Distributed Generation on Power Systems, September 18-19, 1997.

35. "Principles and Applications of Current-Modulated HVDC Transmission Systems," Panel Session on "FACTS Power Electronics Applications to Improve Power System Performance, IEEE Power Meeting, New Orleans, October 9-12, 2005, Co-authors L.O. Barthold, D. Woodford.

36. "Voltage Stability Study of the PJM System Following Extreme Disturbances," Paper 10.1109/TPWRS.2006.887955 IEEE Winter Power Meeting 2006 (co-authors)

37. "Segmentation with Grid Shock Absorbers Ensure Reliability of Large Transmission Interconnections," Power & Energy Magazine, Jan/Feb 2008 (four co-authors).

Articles written for Power Technology:

38. "Improve Stability Studies with Dynamic Load Models," 1975.
39. "An Improved Load Model for Stability Studies," 1978.
40. "Complex Dynamic Simulation Used in Selecting Protection Scheme," 1980.
41. "Conventional Power Flow and Stability Analysis Applied to the Long-Term Simulation Problem," 1982.
42. "Voltage Support in Heavily Loaded EHV Systems," 1984.
43. "Performance Characteristics of Series Compensation and Shunt Var Support," 1984.
44. "An Expanded Role for Back-to-Back DC Converters," 1985.
45. "Protection of Cogeneration and Industrial Generation," 1985.
46. "HVDC - Its Effect on System Performance and Existing AC System Capability," 1985.
47. "Dynamic Stability," 1987, Co-author F.P. de Mello.
48. "Voltage Stability Analysis Requires Accurate QV Curves," 1990.
49. "Hydro Plant Model Sets Record," 1991.
50. "Motor Starters Affect Angular Stability," 1991.
51. "Dynamic Load Models from DSM Recordings," 1992.
52. "Excitation Limiter Performance Is Critical to Voltage Security," 1995.
53. "A New Ball Game," 1996. (Reliability impact of independently owned generation)

Reactive Planning and Voltage Collapse Experience

While performing planning studies for the greater Sao Paulo area in 1973, Mr. Clark recognized the potential for low voltages, motor stalling, and system break-up for certain contingencies. He coined the term "voltage collapse" and proceeded to confirm the problem through simulations using detailed load models. He developed QV curve analysis to help define reactive requirements. Two large synchronous condensers were installed to reduce risk of voltage collapse. Mr. Clark also recommended the first ever use of undervoltage load shedding. This was a landmark effort in that it defined the nature of the voltage collapse problem, provided terminology and tools to address it, and developed solutions. Shortly after this effort Mr. Clark was instrumental in PTI's development of the industry's first long-term simulation capability for the study of the "slow dynamics" of voltage collapse.

Mr. Clark went on to conduct numerous reactive planning and voltage collapse studies. He refined the concept of undervoltage load shedding and demonstrated its effectiveness in several long-term simulation studies for clients facing voltage collapse problems. He contributed to all early IEEE tutorials and working group efforts to define the voltage collapse problem and it's analysis and solutions. He was a frequent speaker at EPRI, NSF and WSCC Seminars on the Voltage Collapse problem.

In 1986 Mr. Clark prepared the PTI "Voltage Course" which covered reactive planning and in particular the nature of the voltage collapse problem and it's analysis and solutions. This course reached more than 1000 students in several dozen countries.

In 1991 Mr. Clark helped Central Power and Light understand an incident on their system (Corpus Christie and southward) that involved "transient voltage collapse" wherein motors slow sufficiently during a fault that the system is unable to re-accelerate them. This same effort also revealed a traditional voltage collapse problem in the Brownsville area near the Mexican border.

In addition to his early IEEE contributions, Mr. Clark has written articles on the voltage collapse problem and on voltage criteria requirements. He has regularly advised clients that voltage problems will be overlooked if studies are limited to the contingencies normally associated with thermal and angular stability criteria.

Blackout Analysis Experience

Mr. Clark's successful career in the planning of reliable transmission systems has been in part the result of first-hand experience with system failures. His investigations of blackouts and major disturbances have equipped him to prepare effective reliability criteria and ensure that those criteria are adequately applied.

WSCC 1996. Mr. Clark was appointed to the Blue Ribbon Panel formed to examine the two 1996 events that caused WSCC break-up and widespread loss of load. He was one of three experts on the panel with reactive planning and voltage stability experience. He prepared a dissenting opinion letter which was published with the Panel Report.

Southern California 1996. One of the two 1996 WSCC-wide events cascaded into angular instability and voltage collapse in a large area of Southern California. Mr. Clark investigated these events and their impact on large industrial customers.

Hawaii 1992. Line outages resulted in unexpected generating plant responses and blackout. Governor overspeed protection caused power swings and voltage regulators on manual control allowed voltage to collapse. Mr. Clark recommended tests and operating practices to reduce the risk of such surprises in the future.

Saudi Arabia 1990. Angular instability that caused blackout was traced to inadequate protection of EHV lines.

Harrison K. Clark 8261 Berg Street Granite Bay CA 95746 www.hkclark.com 916 791-2284

Central America 1996. In a study to improve reliability in six of the seven countries of Central America, Mr. Clark reviewed recent disturbances and guided the development of system upgrades and an interconnection to improve reliability and economic operation.

New Jersey 1974. A medium voltage substation burn-down resulted in extended outages to area customers. Mr. Clark examined the substation physical and protection design and found unprotected bus sections. Major protection updating was required to ensure detection of all faults.

New York City 1977. Mr. Clark assisted the New York Public service commission in its analysis. His operator interviews and related work revealed several important issues that were overlooked by other investigators. He prepared the NY Power Commission's list of questions for Consolidated Edison, and assisted in the analysis of the response. He subsequently supervised analytical work conducted by Consolidated Edison to improve reliability.

Venezuela 1978. A country-wide blackout occurred during a visit by US President Carter. Mr. Clark was a member of a two-man team that spent one month reviewing all Venezuelan planning and operating practices. The team prepared a document that included 23 specific recommendations that would reduce the likelihood of future major outages. President Perez of Venezuela ordered the utilities to implement all 23 recommendations.

St. Johns Newfoundland 1985. System experience and the prospect of greatly increased imports lead to analysis of major disturbances and future reliability. Mr. Clark conducted these analyses and prepared both new planning and operating criteria for the Province and an application guide for the new criteria. He prepared similar criteria for Norway.

USA Midwest 2003. Assistance to certain entities in the Midwest and east subsequent to the 8/14/2003 northeast blackout. Includes advice and training of engineering and operations personnel.

Testimony Experience

In addition to the experience covered in the biography, Mr. Clark has provided expert witness services on occasions as listed below:

Deposition on causes of failure of protection to prevent energization and destruction of the generator of a 400 MW thermal plant during maintenance. Litigation was between the plant owner (Utah Power and Light) and the architect/Engineer responsible for plant and switchyard design.

Extensive testimony on the technical feasibility of planning and operating a 1400 km HVDC transmission system extending from the Churchill Falls plant on the Quebec-Newfoundland border to St. Johns Newfoundland. Testimony addressed steady state and dynamic performance of the line and receiving system. Newfoundland would receive up to 50% of its power from this line. Testimony was on behalf of Newfound Labrador Hydro in action against Hydro Quebec.

Testimony before the Wisconsin Public Service Commission on behalf of Wisconsin P&L and Exxon on the limitations to use of shunt capacitors and static var controllers to extend the capacity of an existing 115 kV system and thereby delay the need for a 345 kV line.

Extensive testimony before the Utah Public Service Commission on behalf of the Utah Association of Municipal Power Cooperatives. UAMPS wished to construct a transmission line from Central Utah to Southwest Utah and Nevada. The testimony focused on the greater ability of the Associations proposed line to serve Southwest Utah reliably and without jeopardizing stability of the greater Utah system as compared to a line proposed by Utah Power and Light.

Testimony before the United States Federal Energy Commission Staff on behalf of Dayton Power and Light in a dispute between DP&L and the City of Piqua over extent and type of interconnection that is

Harrison K. Clark 8261 Berg Street Granite Bay CA 95746 www.hkclark.com 916 791-2284

needed to improve reliability of power supply to Piqua. Effort included visits to substations and lines, review of Piqua and DP&L operating practices, staff quality, and other factors affecting interconnected operation.

Depositions, testimony, and rebuttal testimony before FERC and the Texas Utility Commission in support of the merger of Central and Southwest and El Paso Electric Company.

Testimony before ALJ and a Commissioner of the California Public Utilities Commission regarding use of the ISO generation meter multipliers (GMMs) for the purpose of quantifying loss savings associated with QF power deliveries.

Testimony on behalf of the CPUC's Office of Rate Payer Advocates concerning SDG&E's application for the 500 kV Valley-Rainbow project.

Protection Experience

Mr. Clark's protection experience includes a full year as a relay requisition engineer with General Electric in the medium voltage switchgear department in 1966. In that position he was responsible for preparation for protection equipment design to meet industrial and utility customer specifications. Responsibilities included assembling the necessary complement of relays, laying out the relay panels, and preparing elementary diagrams for the relays, batteries, and breaker trip and close circuits.

For three years (1967-1970) he worked as an application engineer in the GE Industrial Power Systems engineering unit in Schenectady. In this assignment he conducted system analysis and relay application and coordination studies for large paper mills, steel plants, and refineries. The protection studies included utility interconnection protection, coordination with utility relaying, etc.

Mr. Clark joined PTI in 1970, and for several years continued to conduct studies of industrial power systems with heavy emphasis on protective systems. He was solely responsible for relay selection and settings in the 200 MW isolated power system (240 V through 13.8 kV) of the Amerada Hess refinery in the Virgin Islands, and continues to consult with Amerada Hess today.

In the mid 1970's his responsibilities shifted to EHV planning. In transmission planning and design studies for clients in South America he was frequently responsible for recommending protective systems for special situations, including compatibility with existing protective systems, out-of-step blocking and tripping in systems subject to instability, overvoltage protection for systems subject to radial load rejection and self-excitation, comparison of reliability of blocking and unblocking directional comparison schemes where sympathetic line trip was a special problem, and others. One study required development of a detection scheme for impending self-excitation based on generator terminal overvoltage and negative field current relays.

Mr. Clark assisted the New York Public Service Commission in its investigation of the 1977 New York City blackout, including the role of protection in the cascading process. He identified 7 relay problems that contributed to the cascading or delayed restoration. In 1978 he was the coauthor of a report on a country-wide blackout in Venezuela. The report included 23 recommendations to reduce risk of future similar occurrences, six of which addressed relay problems that contributed to cascading and restoration problems.

In 1978 he investigated a major substation burndown that was traced to a fault that was in a gap between first zone protection zones, and which interrupted trip circuits of backup protection thereby preventing clearing.

In 1979 he conducted an extensive dynamics study to specify a protection system for the Guri 800 kV system in Venezuela. This coordinated protective system addressed stability and cascading problems with

Harrison K. Clark 8261 Berg Street Granite Bay CA 95746 www.hkclark.com 916 791-2284

out-of-step block and trip relays, overvoltage relays, and a unit tripping scheme.

He conducted failure modes and effects analysis on a complete nuclear station auxiliary system, including protection, battery systems, and automatic controls for starting of diesels and emergency coolant drives.

Since 1983 he has conducted a number of cogeneration protection studies, including voltage levels from 480 volts through 138 kV. In 1985 he conducted a coordination study for the Electric Boat Division of General Dynamics facility in Connecticut. This study covered over 400 protective devices from 220 volts through 69 kV.

He analyzed the protective equipment and circuitry that failed to prevent catastrophic damage to a large generating unit when it was accidentally energized from the EHV system. He provided testimony during litigation that followed this incident.

In 1984 and 1985 he investigated two breaker failure disturbances for a midwest client, both traced to relay problems at 69 and 230 kV. Problems included wiring errors and inappropriate relay settings.

In 1986 Mr. Clark also investigated the protection problems that could result from the operation of two parallel 300 kV lines with existing shield wires removed. These lines are in an area where tower footing resistance ranges from 20 to over 250 ohms. Various relay options, including wave relays were considered.

In 1986 he also documented potential fault level, grounding, and protection problems associated with cogeneration on distribution systems for a client, and reviewed six planned cogeneration interconnections for the same client.

In 1987 he investigated a 1986 disturbance in the Orange and Rockland system and identified from oscillographs and simulations a number of relay problems including sympathetic trip and out-of-step tripping.

Mr. Clark prepared the Power Technology Course unit on protection and taught this unit for 17 years. His course notes for the unit are used in the graduate program at the University of Sao Paulo. He has written papers on industrial plant load shedding and on microprocessor based industrial load shedding. He co-authored a paper on interconnection protection problems associated with customer owned generation and system dynamics for the annual IEEE-IAS meeting in 1986.

Harrison K. Clark 8261 Berg Street Granite Bay CA 95746 www.hkclark.com 916 791-2284

EXHIBIT B

GRID INTERCONNECTION COST CONSIDERATIONS

The cost of connecting solar and wind plants to the electric grid does to some extent change step-wise with plant size. However, the steps are not well defined and there are other factors so plant size is not the only determinant of cost.

Interconnections costs vary primarily with the voltage at which the interconnection occurs. While larger generators will connect at higher voltages and smaller ones at lower voltages, there is some overlap, say where a certain size generating plant could be accommodated at 46 kV or 138 kV or a smaller plant could be accommodated at 4 kV or 46 kV.

The significant interconnection cost items are the buswork, circuit breakers, disconnect switches, transformer, protection, and land for this equipment as well as for new right-of-way if needed and conductor upgrades. All of these items cost disproportionately more as voltage increases (4 kV, 12 kV, 25 kV, 46 kV, 69 kV, and 138 kV). A circuit breaker, for instance, costs roughly twice the voltage, i.e., $92K at 46 kV or $276,000 at 138 kV. The same size transformer costs more when designed for a higher voltage, so transformer costs go up with capacity <u>and</u> voltage rating. More elaborate switching station arrangements are typically used for reliability purposes at higher voltages and require more circuit breakers per terminal than at lower voltages and more land. At the lowest voltages circuit breakers may not be required with less costly fuses and disconnect switches sufficing. In the limit, pole-top equipment is used and no land is needed.

A plant large enough to require a 138 kV connection will thus pay far more per kW than a modestly smaller plant that can be accommodated at 46 kV. The smaller plant may, however, only have the option of a 138 kV interconnection if there is no 46 kV line nearby.

At the small-plant end, where the generating plant is on a distribution circuit, the costs are far lower than at "transmission" voltages, but can vary widely. In a very small plant that sits behind an existing meter and does not cause power delivered to exceed the previously purchased power level, the cost is likely to be very modest, possibly requiring only some adjustment to protection or the addition of a communications circuit to trip the plant when the feeder trips, for safety reasons. The pole-top or padmount transformer and switching and fuse equipment may not need to be changed.

As the plant size grows relative to existing available distribution feeder equipment at and near the point of interconnection, costs will at some plant size increase to cover protection additions and changes, possibly expansion of a single-phase "lateral" to three-phase, modification of reclosing, etc. A given size plant may require such upgrades at one location but not at another. Hence costs will not be sharply defined by plant size though larger plants are more likely to require greater changes to the distribution feeder. A plant close to a substation is less likely to face upgrade costs than one near the end of a feeder.

While the cost of interconnection does tend to rise with plant size, there are many variables that make generalizations unreliable. A catalog of typical costs could be assembled by the utility by choosing an arbitrary assortment of plant locations and pricing each one for a range of plant sizes that could be accommodated at each location.

EXHIBIT C

TPL'S PROPOSED PHONEBOOK FORMAT FOR A TRANSPARENT AND EFFICIENT DETERMINATION AND APPLICATION OF INTERCONNECTION COSTS IN HAWAII

The following matrix represents hypothetical information for illustrations purposes only. The displayed format should reflect what a page in the proposed Phonebook might look like for each HECO company.

Proposed Format for A HECO Utility Interconnection Phonebook

Interconnection Point ID [1]	Type [2]	Location Address [3]	Voltage (kV)	Generation Size Tier (kW) [4]	System Reinforcement Cost or Credit ($ per kW) [5]	Capacity Loss Adjustment Factor [6]	Energy Loss Adjustment Factor [6]
UVW-123	Feeder #2	Starting longitude/latitude	12	< 300	0	1.07	1.04
	Overhead	Ending longitude/latitude		< 700	100		
				≤ 1,000	350		
XYZ-456	Feeder #3	Starting longitude/latitude	4	< 100	50	1.08	1.06
	Overhead	Ending longitude/latitude		< 300	120		
				≤ 500	200		

1. Unique utility identifier (e.g., name, number)
2. For example, substation, primary feeder, pole mounted transformer, etc.
3. Other ways (e.g., zip codes) can be used. Information can be provided under suitable restrictions.
4. The value assigned to the highest tier represents the total permissable (interconnectable) generating capacity.
5. For as many tiers of total interconnectable generating capacity as needed. Negative values represent credit.
6. Multiplier that produce the average equivalent deliverable capacity or energy from the new generator to the system.

As indicated in the table's footnotes, the values in the "Generation Size Tier" column represent the total generating capacity that would trigger a change in the expected system reinforcement cost or credit at the identified location. The bottom (largest) entry in this column signifies the maximum total capacity that can be allowed at the applicable location. For example, the total allowable generating capacity for the first (top) interconnection point is 5 MWs.

EXHIBIT D

EXAMPLE OF A PAGE FROM THE INTERCONNECTION PHONEBOOK OF PACIFIC GAS AND ELECTRIC COMPANY ("PGandE")

The copy provided on the second page of this exhibit represents a sample from the interconnection phonebook used by PGandE before the restructuring of the power industry in California. The following should be noted:

- The interconnections points shown are for high voltage levels (60 kV and greater). Hence, the total generating capacities that can be interconnected are quite large with nothing less than 30 MWs.
- Consequently, the interconnection costs listed under the column labeled "System Reinforc Adjustment (SRA)" tend to be relatively modest on a per-kW basis. Such economy of scale may not be as dramatic or common for distribution-level applications. This means the Phonebook concept might be very important for secondary and primary distribution voltage cases as well as for subtransmission

Transmission OII 90-09-050
Pacific Gas and Electric Company
Incremental Transmission Impact Evaluation (Location Attribute)
DRAFT 1998 Proxy First-Year Ramped Costs
December 15, 1992

COUNTY: ALAMEDA

SUBSTATION NAME	ADDRESS	BUS VOLTAGE CLASS (KV)	CAPACITY LOSS ADJUST. FACTOR (CLAF)	ENERGY LOSS ADJUST. FACTOR (ELAF)	GEN. SIZE (MW)	SYSTEM REINFORC. ADJUSTMENT (SRA) ($/KW)
LAS POSITAS	SOUTH OF HIGHWAY 580:NEAR INTERSECTION HWY 84	230	1.03	1.02	83.	-4.09
					167.	-2.22
					250.	1.74
		60	1.03	1.02	10.	-1.00
					20.	-1.00
					30.	0.20
*LAWRENCE RADIATION	NOT AVAILABLE	230	1.00	1.00	83.	2.87
					167.	2.87
					250.	5.42
		115	1.00	1.00	30.	3.42
					60.	3.56
					90.	3.56
LIVERMORE	1300 RAILROAD AVE	60	1.06	1.03	10.	-2.45
					20.	-1.49
					30.	-0.70
MOUNT EDEN	2541 DARWIN ST	115	1.07	1.04	30.	-3.73
					60.	-3.73
					90.	-3.73
NEWARK	6453 DURHAM ROAD	230	1.05	1.03	83.	4.28
					167.	4.28
					250.	5.14
		115	1.05	1.03	30.	-4.12
					60.	-4.12
					90.	-4.12
		60	1.06	1.03	10.	-4.19
					20.	-4.19
					30.	-4.19
NEWARK DISTRIBUTIO	6453 DURHAM ROAD	115	1.06	1.03	30.	-4.19
					60.	-4.19
					90.	-4.19
PARKS	U.S. ARMY BASE :3M E/O DUBLIN	60	1.07	1.04	10.	-2.98
					20.	-2.48
					30.	0.02

* Not a PG&E-owned substation. See the Introduction to the LOCATION Table for possible limitations to interconnections.

CERTIFICATE OF SERVICE

The foregoing Opening Statement of Position was served on the date of filing by hand delivery or electronically transmitted to each such Party.

CATHERINE P. AWAKUNI EXECUTIVE DIRECTOR DEPT OF COMMERCE & CONSUMER AFFAIRS DIVISION OF CONSUMER ADVOCACY P.O. Box 541 Honolulu, Hawaii 96809	2 Copies Via Hand Delivery
MR. DEAN MATSUURA MANAGER REGULATORY AFFAIRS HAWAIIAN ELECTRIC COMPANY, INC. P.O. Box 2750 Honolulu, HI 96840-0001	Electronically transmitted
MR. JAY IGNACIO PRESIDENT HAWAII ELECTRIC LIGHT COMPANY, INC. P. O. Box 1027 Hilo, HI 96721-1027	Electronically transmitted
MR. EDWARD L. REINHARDT PRESIDENT MAUI ELECTRIC COMPANY, LTD. P. O. Box 398 Kahului, HI 96732	Electronically transmitted
THOMAS W. WILLIAMS, JR., ESQ. PETER Y. KIKUTA, ESQ. DAMON L. SCHMIDT, ESQ. GOODSILL, ANDERSON QUINN & STIFEL Alii Place, Suite 1800 1099 Alakea Street Honolulu, Hawaii 96813	Electronically transmitted

Co-Counsel for HECO, HELCO, and MECO

//

ROD S. AOKI, ESQ.
ALCANTAR & KAHL LLP
120 Montgomery Street
Suite 2200
San Francisco, CA 94104

Electronically transmitted

Co-Counsel for HECO, HELCO, and MECO

MARK J. BENNETT, ESQ.
DEBORAH DAY EMERSON, ESQ.
GREGG J. KINKLEY, ESQ.
DEPARTMENT OF THE ATTORNEY GENERAL
425 Queen Street
Honolulu, Hawaii 96813

Electronically transmitted

Counsel for DBEDT

CARRIE K.S. OKINAGA, ESQ.
GORDON D. NELSON, ESQ.
DEPARTMENT OF THE CORPORATION COUNSEL
CITY AND COUNTY OF HONOLULU
530 South King Street, Room 110
Honolulu, Hawaii 96813

Electronically transmitted

LINCOLN S.T. ASHIDA, ESQ.
WILLIAM V. BRILHANTE JR., ESQ.
MICHAEL J. UDOVIC, ESQ.
DEPARTMENT OF THE CORPORATION COUNSEL
COUNTY OF HAWAII
101 Aupuni Street, Suite 325
Hilo, Hawaii 96720

Electronically transmitted

MR. HENRY Q CURTIS
MS. KAT BRADY
LIFE OF THE LAND
76 North King Street, Suite 203
Honolulu, Hawaii 96817

Electronically transmitted

MR. CARL FREEDMAN
HAIKU DESIGN & ANALYSIS
4234 Hana Highway
Haiku, Hawaii 96708

Electronically transmitted

//

MR. WARREN S. BOLLMEIER II | Electronically transmitted
PRESIDENT
HAWAII RENEWABLE ENERGY ALLIANCE
46-040 Konane Place, #3816
Kaneohe, Hawaii 96744

DOUGLAS A. CODIGA, ESQ. | Electronically transmitted
SCHLACK ITO LOCKWOOD PIPER & ELKIND
TOPA FINANCIAL CENTER
745 Fort Street, Suite 1500
Honolulu, Hawaii 96813

Counsel for BLUE PLANET FOUNDATION

MR. MARK DUDA | Electronically transmitted
PRESIDENT
HAWAII SOLAR ENERGY ASSOCIATION
P.O. Box 37070
Honolulu, Hawaii 96837

MR. RILEY SAITO | Electronically transmitted
THE SOLAR ALLIANCE
73-1294 Awakea Street
Kailua-Kona, Hawaii 96740

MR. JOEL K. MATSUNAGA | Electronically transmitted
HAWAII BIOENERGY, LLC
737 Bishop Street, Suite 1860
Pacific Guardian Center, Mauka Tower
Honolulu, Hawaii 96813

KENT D. MORIHARA, ESQ. | Electronically transmitted
KRIS N. NAKAGAWA, ESQ.
SANDRA L. WILHIDE, ESQ.
MORIHARA LAU & FONG LLP
841 Bishop Street, Suite 400
Honolulu, Hawaii 96813

Counsel for HAWAII BIOENERGY, LLC
Counsel for MAUI LAND & PINEAPPLE COMPANY, INC.

MR. THEODORE E. ROBERTS | Electronically transmitted
SEMPRA GENERATION
101 Ash Street, HQ 12
San Diego, California 92101

MR. CLIFFORD SMITH
MAUI LAND & PINEAPPLE COMPANY, INC.
P.O. Box 187
Kahului, Hawaii 96733

Electronically transmitted

MR. ERIK KVAM
CHIEF EXECUTIVE OFFICER
ZERO EMISSIONS LEASING LLC
2800 Woodlawn Drive, Suite 131
Honolulu, Hawaii 96822

Electronically transmitted

MR. JOHN N. REI
SOPOGY INC.
2660 Waiwai Loop
Honolulu, Hawaii 96819

Electronically transmitted

GERALD A. SUMIDA, ESQ.
TIM LUI-KWAN, ESQ.
NATHAN C. NELSON, ESQ.
CARLSMITH BALL LLP
ASB Tower, Suite 2200
1001 Bishop Street
Honolulu, Hawaii 96813

Electronically transmitted

Counsel for HAWAII HOLDINGS, LLC,
dba FIRST WIND HAWAII

MR. CHRIS MENTZEL
CHIEF EXECUTIVE OFFICER
CLEAN ENERGY MAUI LLC
619 Kupulau Drive
Kihei, Hawaii 96753

Electronically transmitted

//

//

//

//

//

//

SANDRA-ANN Y.H. WONG, ESQ.
ATTORNEY AT LAW, A LAW CORPORATION
1050 Bishop Street, #514
Honolulu, HI 96813

Electronically transmitted

Counsel for ALEXANDER & BALDWIN, INC.,
Through its division, HAWAIIAN COMMERCIAL & SUGAR COMPANY

DATED: Honolulu, Hawaii, May 8, 2009.

HARLAN Y. KIMURA

Attorney for Movant
Tawhiri Power LLC